**SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**

# Draft Socioeconomic Report For PROPOSED AMENDED REGULATION XX–REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM)

## October 2010


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# EXECUTIVE SUMMARY

The proposed amendments to Regulation XX—Regional Clean Air Incentives Market (RECLAIM)—would reduce the allowable SOx emission limits based on current Best Available Retrofit Control Technology (BARCT) for several industrial equipment and processes. A socioeconomic assessment was conducted for the proposed amendments and a summary of the assessment and findings is presented below.

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| **Elements of the Proposed Amendments** | The proposed amendments to REgional Clean Air Incentives Market (RECLAIM) would reduce allowable SOx emissions at 11 SOx RECLAIM facilities by reducing their RECLAIM Trading Credits (RTCs). These facilities hold 90 percent of SOx RTCs and generate 95 percent of SOx emissions. In order to ensure that their emissions not exceed the allowable RTCs, these facilities would be required to install or modify SOx emission controls on the following types of equipment and processes: 1) refinery fluid catalytic cracking units (FCCU), 2) refinery sulfur recovery units (SRU), 3) sulfuric acid manufacturing processes, 4) container glass melting furnace, 5) Portland cement manufacturing, and 6) petroleum coke calciner.<br><br>The proposed amendments would result in a reduction of 4.5 tons and 6.14 tons per day of SOx RTCs in 2014 and 2019, respectively. |
| **Affected Facilities** | The proposed amendments will affect 11 SOx RECLAIM facilities. The six affected refineries, one coke calciner unit, and one sulfuric acid plant belong to the sector of petroleum product manufacturing. The refinery FCCU units, refinery sulfur recovery units, refinery boilers/heaters, coke calciner plant, and one sulfuric acid plant operate in this sector. The affected cement and the glass plants belong to the non-metallic mineral product manufacturing sector, and one out of two affected sulfur acid plants belongs to the chemical manufacturing sector. Of these 11 facilities, 10 are located in Los Angeles County and the remaining one is located in San Bernardino County. |
| **Assumptions of Analysis** | To meet the proposed SOx reduction, it is expected that the affected facilities would use a variety of SOx control technologies, including wet gas scrubbers (WGSs), dry gas scrubbers (DGSs), EmeraChem ESx catalyst, Cansolv upgrade, and SOx reducing additives.<br><br>It is further assumed that four WGSs would be installed on the FCCU units at four refineries. It is also assumed that three refineries would install three WGSs and one EmeraChem ESx catalyst on their three affected SRU units. One refinery is expected to install two WGSs on its SRU unit. It is assumed that |

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| **Assumptions of Analysis** | one of the two affected sulfuric acid manufacturing facilities would use a WGS and the other would use Cansolv upgrade to comply with the proposed amendments. It is assumed that the one affected glass melting facility would install two WGSs, one affected cement plant would install two dry gas scrubbers, and one affected petroleum coke calcining facility would install one WGS scrubber to further control SOx emissions.<br><br>Control costs vary by equipment type and size. The total compliance cost of the proposed amendments includes one-time cost and recurring costs. The one-time cost includes the capital costs of WGSs, DGSs, EmeraChem ESx catalyst, Cansolv upgrade, and their installations (demolition, concrete, structural, piping, electrical, contractors, contingencies), and major maintenance services at five-year intervals. The one-time costs are annualized assuming a 25-year life for equipment and installation, and a real interest rate of four percent.<br><br>The annual operating costs include utilities (natural gas, electricity, water, waste water, cooling water, and compressed air), solid waste from catalyst fines, and additional chemicals used. The annual maintenance costs include general maintenance of SOx control equipment, which include both labor and materials, including catalyst replacement. |
| **Compliance Costs** | In 2009, ETS Inc. and NEXIDEA Inc. provided cost estimates of SOx emission controls to the District, which was evaluated by Norton Engineering Consultants (NEC) in March 2010. The cost analysis herein is based on the cost estimates provided by these two consultants. The average annual compliance costs are estimated from $32 million to 42 million.<br><br>Based on the ETS/NEXIDEA estimates, the average annual cost of the proposed amendments is estimated at $32.2 million between 2011 and 2030. The majority of the compliance cost ($28 million or 87 percent) is expected to be incurred by the petroleum product manufacturing sector where the six affected refineries belong. Of the three processes, refinery FCCU units would face the highest annual compliance cost of $17.7 million.<br><br>The sectors of non-metallic mineral product (affected cement and glass plants) and the chemical manufacturing (one affected sulfur acid plant) are expected to incur lower shares of the total annual compliance cost ($3.14 and $1.03 million, respectively).<br><br>NEC provided input in calculating capital and maintenance costs estimates for the individual facilities across the six source |

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| | categories and provided cost adjustment factors where applicable. Except for one FCCU in a refinery and a glass plant, NEC's input were higher values than those from the ETS/NEXIDEA. Based on the NEC's cost estimates, the average annual cost of the proposed amendments is estimated at $42 million between 2011 and 2030. The majority of the compliance cost ($36 million or 86 percent) is expected to incur in the sector of petroleum product manufacturing where the six affected refineries belong. Refinery FCCU units would face the highest compliance cost of $18.8 million (43 percent of the total cost). |
| **Employment Impacts** | Based on the above assumptions, the compliance cost of proposed amendments provided by ETS/NEXIDEA and inputs from NEC consultants, and the application of the Regional Economic Models, Inc. (REMI) model, it is projected that an average of two to nine jobs could be forgone annually between 2011 and 2030. Equipment installation would start in the year 2011 and through 2019. In earlier years, the positive job impact from the expenditures made by refineries, glass, cement and sulfur acid plants would more than offset the jobs forgone from the additional cost of doing business. The positive job impact would trickle down to the sectors of construction, miscellaneous professional services, retail, wholesale, and business services.<br><br>However, as refineries, glass, cement, and sulfur acid plants continue to amortize their capital expenditures in earlier years, reductions in job growth would set in, resulting in fewer jobs created in later years. Projected jobs forgone are spread throughout different sectors of the economy.<br><br>Despite its high compliance costs, the refinery industry is projected to have only four to five jobs forgone annually, on average. |
| **Competitiveness** | Affected sectors would experience minor increases in the relative cost of production and relative delivered price with respect to their counterparts in the rest of the U.S. Based on the ETS/NEXIDEA cost estimates, it is projected that the refinery industry would experience a rise in its relative cost of production of 0.18 percent and a rise in its delivered price of 0.12 percent in 2019. Based on the cost estimates derived based on NEC's input, it is projected that the refinery industry would experience a rise in its relative cost of production by 0.21 percent and a rise in its delivered price by 0.15 percent in 2019. |
| **CEQA Alternatives** | There are three CEQA alternatives associated with the proposed amendments. Alternative A is the No Project Alternative, which is the existing SOx RECLAIM program. Alternative B is Control Measure CMB-02 (Further SOx Reduction for RECLAIM SOx) in the 2007 AQMP which has lower emission reductions than the |

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| | proposed amendments. Alternative C would exclude the sulfur recovery category from the proposed amendments.<br><br>There is no Impact from Alternative A. Average annual compliance costs for Alternative B and Alternative C are estimated to be $3.1 and $23.4 million between 2011 and 2030, respectively. Jobs forgone for the Alternatives B and Alternative C are estimated to be 29 and 37, between 2011 and 2030, respectively. |
| **WSPA Scenario** | Western States Petroleum Association (WSPA) requested that staff analyze a scenario with three times higher costs than staff's estimates for FCCU and sulfur recovery units. The average annual cost of the proposed amendments under this scenario is estimated at $85.2 million between 2011 and 2030. The majority of the compliance cost ($81 million or 95 percent) is expected to be incurred by the petroleum product manufacturing sector where the six refineries belong. Refinery FCCU units would face the highest compliance cost of $53 million (62 percent of total cost).<br><br>It is projected that an average of 202 jobs could be created annually between 2011 and 2030. In earlier years, the positive job impact from the expenditures made by refineries, glass, cement and sulfur acid plants would more than offset the jobs forgone from the additional cost of doing business. The positive job impact would trickle down to the sectors of construction miscellaneous professional services, retail, wholesale, and business services.<br><br>It is projected that the refinery industry would experience a rise in its relative cost of production by 0.51 percent and a rise in its delivered price by 0.36 percent in 2019. |

# INTRODUCTION

The proposed amendments to Regional Clean Air Incentives Market (RECLAIM) would reduce allowable SOx emissions at 11 SOx RECLAIM facilities by reducing their RECLAIM Trading Credits (RTCs). These facilities hold 90 percent of SOx RTCs and generate 95 percent of SOx emissions. In order to ensure that their emissions not exceed the allowable RTCs, these facilities would require to install or modify SOx emission controls on the following types of equipment and processes: 1) refinery fluid catalytic cracking units (FCCU); 2) refinery sulfur recovery units (SRU), 3) sulfuric acid manufacturing processes, 4) container glass melting furnace, 5) Portland cement manufacturing, and 6) petroleum coke calciner. RTCs would be reduced by 4.5 tons and 6.14 tons per day in 2014 and 2019, respectively.

# LEGISLATIVE MANDATES

The socioeconomic assessments at the South Coast Air Quality Management District (AQMD) have evolved over time to reflect the benefits and costs of regulations. The legal mandates directly related to the assessment of the proposed rules and amendments include the AQMD Governing Board resolutions and various sections of the California Health & Safety Code (H&SC).

### AQMD Governing Board Resolutions

On March 17, 1989 the AQMD Governing Board adopted a resolution that calls for preparing an economic analysis of each proposed rule or amendment for the following elements:

- Affected Industries
- Range of Control Costs
- Cost Effectiveness
- Public Health Benefits

On October 14, 1994, the Board passed a resolution which directed staff to address whether the proposed rules or amendments brought to the Board for adoption are in the order of cost effectiveness as defined in the AQMP. The intent was to bring forth those rules that are cost-effective first.

### Health & Safety Code Requirements

The state legislature adopted legislation that reinforces and expands the Governing Board resolutions for socioeconomic assessments. H&SC Sections 40440.8(a) and (b), which became effective on January 1, 1991, require that a socioeconomic analysis be prepared for any proposed rule or rule amendment that *"will significantly affect air quality or emissions limitations."* Specifically, the scope of the analysis should include:

- Type of Affected Industries
- Impact on Employment and the Economy of the Basin

- Range of Probable Costs, Including Those to Industries
- Emission Reduction Potential
- Necessity of Adopting, Amending or Repealing the Rule in Order to Attain State and Federal Ambient Air Quality Standards
- Availability and Cost Effectiveness of Alternatives to the Rule

For the items 1, 4, 5, and 6 above, please refer to Staff Report of Proposed Amended SOx RECLAIM. Additionally, the AQMD is required to actively consider the socioeconomic impacts of regulations and make a good faith effort to minimize adverse socioeconomic impacts. H&SC Section 40728.5, which became effective on January 1, 1992, requires the AQMD to:

- Examine Business and Small Business Impacts; and
- Consider Socioeconomic Impacts in Rule Adoption

H&SC Section 40920.6, which became effective on January 1, 1996, requires that incremental cost effectiveness be performed for a proposed rule or amendment relating to ozone, carbon monoxide (CO), oxides of sulfur ($SO_x$), oxides of nitrogen ($NO_x$), and their precursors. Incremental cost effectiveness is defined as the difference in costs divided by the difference in emission reductions between one level of control and the next more stringent control. Incremental cost effectiveness analysis is presented in the staff report prepared for the proposed amendments.

## AFFECTED FACILITIES

The proposed amendments will affect 11 SOx RECLAIM facilities that have the following types of equipment or processes: 1) refinery fluid catalytic cracking units (FCCU), 2) refinery sulfur recovery units, 3) sulfuric acid manufacturing processes, 4) container glass melting furnaces, 5) Portland cement manufacturing, and 6) petroleum coke calciner. In addition, the proposed amendments may affect certain existing refinery boilers/heaters that are not meeting the current BARCT limit.

The six affected refineries belong to the sector of petroleum product manufacturing. This sector operates the refinery FCCU units, refinery sulfur recovery units, refinery boilers /heaters, one sulfuric acid plant, and coke calciner units. The affected cement and the glass plants belong to the non-metallic mineral product manufacturing sector, and one out of the two affected sulfur acid plants belong to the chemical manufacturing sector. Of these 11 facilities, 10 are located in Los Angeles County and the remaining one is located in San Bernardino County.

### Small Businesses

The AQMD defines a "small business" in Rule 102 as one which employs 10 or fewer persons and which earns less than $500,000 in gross annual receipts. In addition to the AQMD's definition of a small business, the federal Small Business Administration (SBA), the federal Clean Air Act Amendments (CAAA) of 1990, and the California

Department of Health Services (DHS) also provide their own definitions of a small business.

The SBA's definition of a small business uses the criterion of gross annual receipts (ranging from $0.75 million to $35.5 million), number of employees (ranging from 50 to 1,500), megawatt hours generated (4 million), or assets ($175 million), depending on the industry type (US SBA, 2008). The SBA definitions of small businesses vary by 6-digit North American Industrial Classification System (NAICS) code. For instance, the sector of petroleum refineries (NAICS 324110) has 1,500 employees as the threshold below which a business is considered small. For the sector of non-metallic mineral products (NAICS 327310 and NAICS 327213) which includes cement and glass plants, fewer than 750 employees is the criterion below which a business is considered small.

The CAAA classifies a facility as a "small business stationary source" if it: (1) employs 100 or fewer employees, (2) does not emit more than 10 tons per year of either VOC or NOx, and (3) is a small business as defined by SBA.

None of the affected facilities are considered small businesses under any of the small business definitions discussed above. Based on the 2009 annual financial report, the total gross annual revenue of the corporations where the six affected refineries belong (ranging from $16 to $285 billion) was about $945.5 billion. The remaining affected facilities include California Portland Cement Company (CPCC), Rhodia Sulfur Acid Plant, and Owens-Brockway Glass plant. The CCCP is a subsidiary of Taiheiyo Cement Company in Japan with gross annual sales of over $4.3 billion in 2009. The Rhodia and Owens-Brockway companies reported gross annual sales of about $5.2 and $7.1 billion in 2009, respectively.

## COMPLIANCE COST

The proposed amendments would require 11 SOx RECLAIM facilities to install or modify SOx emission controls on the following types of equipment and processes: : 1) refinery fluid catalytic cracking units (FCCU), 2) refinery sulfur recovery units, 3) sulfuric acid manufacturing process, 4) container glass melting furnaces, 5) Portland cement manufacturing, and 6) petroleum coke calciner.

In 2009, ETS Inc. and NEXIDEA Inc. provided cost estimates of SOx emission controls to the District, which was evaluated by Norton Engineering Consultants (NEC) in March 2010. The cost analysis herein is based on the cost estimates provided by these two consultants.

### Cost Based on ETS/NEXIDEA Estimates

Under the proposed amendments, the SOx RTCs would be reduced to 7.3 tons per day by 2014, and 5.7 tons per day by 2019 from a total of 11.7 tons per day. The affected sources would reduce their emissions to meet the proposed allowable SOx RTCs. Based on the required construction time (Table 1) and cost-effectiveness of control equipment (Table 2), a construction schedule (Table 2) was developed to ensure the projected

emission reductions in 2014 and 2019 would be achieved. It was assumed that the most cost-effective SOx control equipment would be installed or modified first.

**Table 1**
**Construction Time by Source Category and Control Equipment**

| Source Category | Control Equipment | Required Time |
|---|---|---|
| FCCU | Wet Gas Scrubber | 3 years |
| SRU | Wet Gas Scrubber | 3 years |
| Coke Calciner | Wet Gas Scrubber | 2 years |
| Sulfuric Acid | Wet Gas Scrubber | 2 years |
| SRU | Emerachem ESx | 2 years |
| Cement | Dry Gas Scrubbers | 2 years |
| Sulfuric Acid | Cansolv Upgrade | 1 year |
| Glass | Wet Gas Scrubbers | 1 year |

As shown in Table 2, more expensive controls would not be installed until 2016 to 2019. Based on this schedule and facility-specific estimates, the average annualized cost of the proposed amendments is estimated to be $32.2 million between 2011 to 2030. The refinery FCCU units are estimated to have the highest average annual compliance cost of $17.6 million (55 percent) among all the affected source categories. Table 3 presents the estimated average annual cost of the proposed amendments by equipment

**Table 2**
**Distribution of Control Equipment by Equipment Category and by Cost-Effectiveness (2011-2019)**

| Equipment Category | 2011-12 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ | # of Eq | C-E $ |
| Refinery FCCU Units | | | | | 1 | 12,849 | 1 | 14,437 | | | 1 | 36,636 | | | 1 | 42,103 |
| Refinery SRU Units | | | | | 1 | 12,880 | | | 1 | 36,359 | | | 1 | 39,000 | | |
| Cement Plant[1] | | | 1 | 19,300 | | | | | | | | | | | | |
| Glass Plants | | | 1 | 5,198 | | | | | | | | | | | | |
| Sulfur Acid Plants | 1 | 1,896 | 1 | 5,556 | | | | | | | | | | | | |
| Coke Calciner | | | 1 | 9,902 | | | | | | | | | | | | |
| **Total** | **1** | | **4** | | **2** | | **1** | | **1** | | **1** | | **1** | | **1** | |

[1]In late 2009, CPCC announced the shutdown of two cement kilns, which may or may not be permanent, depending on the state of the economy. Table 2 assumes that CPCC would either sell its unused RTCs in 2013 or install control equipment to achieve emission reductions.

**Table 3**
**Average Annual Cost Based on ETS/NEXIDEA Estimates**
**by Equipment Category**
**(millions of 2010 dollars)**

| Equipment Category | 2011 | 2014 | 2019 | 2030 | Average Annual (2011-2030) |
|---|---|---|---|---|---|
| Refinery FCCU Units | $1.93 | $11.95 | $21.29 | $21.29 | $17.65 |
| Refinery Sulfur Recovery Units | $0.00 | $3.30 | $11.30 | $11.30 | $8.83 |
| Coke Calciner | $0.43 | $1.59 | $1.59 | $1.59 | $1.49 |
| Sulfur Acid Plant at Refinery | $0.03 | $0.10 | $0.10 | $0.10 | $0.10 |
| Cement Plant | $0.61 | $2.81 | $2.81 | $2.81 | $2.62 |
| Glass Plant | $0.00 | $0.57 | $0.57 | $0.57 | $0.52 |
| Sulfur Acid Plant | $0.21 | $1.11 | $1.11 | $1.11 | $1.03 |
| | | | | | |
| **Total** | **$3.21** | **$21.43** | **$38.77** | **$38.77** | **$32.24** |

The majority of the compliance cost ($28.07 million or 87 percent) is expected to occur in the petroleum product manufacturing sector where the six affected refineries belong. The refinery FCCU units, refinery sulfur recovery units, coke calciner units, and one of the sulfuric acid plants operate in this sector. The non-metallic mineral product manufacturing sector operates cement and the glass plants. One of the two affected sulfur acid plants belongs to the chemical manufacturing sector.

Based on the 2009 annual financial report, the total gross annual revenue of the corporations where the six affected refineries belong was about $945.5 billion. Based on this estimate, the refineries total annualized cost ($28 million) represents approximately 0.003 percent of their estimated corporate gross annual sales.

According to the 2009 California State Board of Equalization, the total gasoline sales in California was 14.8 billion gallons, of which the South Coast's share is estimated to be 46 percent. The compliance cost of the proposed amendments, if fully passed on to gasoline consumers, would result in a gasoline price increase of 0.5 cents per gallon in the four-county area.

The detailed compliance cost assumptions for each source category based on consultant's (ETS/NEXIDEA) information on each facility are discussed below.

**Refinery FCCUs**

The FCCUs are classified as major sources of SOx emissions in RECLAIM, and, as such, the emissions from FCCUs are required to be monitored with continuous emission monitoring system, and reported on a daily basis electronically to the District. There are six refineries that operate six fluid catalytic cracking units (FCCU) in the District. Currently, these refineries are processing low sulfur feed stocks with feed hydro-treating. The proposed amendments would require a BARCT level of 5 ppmv for SOx emissions at these six affected refineries. It is assumed that installation of WGSs could achieve a level of limit of 5 ppmv at these refineries. Out of these six refineries, one has installed a WGS to reduce SOx and PM and is thus already in compliance with the proposed

BARCT limit. As a result, no additional cost was attributed to this facility. Another refinery has heavily treated its FCCU feed to the low 10 ppmv level; therefore, installing a WGS to get to a level of 5 ppmv is not cost-effective. This company may seek additional reductions from other source categories that are affected by the proposed amendments. Therefore, no additional cost was ascribed to this refinery.

The four remaining refineries are assumed to install one WGS each to achieve the proposed SOx emission limit. The total compliance cost of the proposed amendments for refinery FCCUs includes one-time cost and recurring cost. The one-time cost includes the capital cost of WGSs and their installations (demolition, concrete, structural, piping, electrical, contractors, contingencies), and major maintenance services at five-year interval. The analysis herein does not include the equipment salvage values mainly due to the fact that these values will not be realized until after the end of the useful life of the equipment (25 years), which is outside of the model simulation period.[2] The annual costs are additional operating and maintenance costs of those new WGSs.

The capital costs of four new WGSs range from $19.06 million to $39.47 million depending on the characteristics of each refinery. Installation costs of these WGSs range from 27.50 to $51 million. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the refinery FCCUs is estimated at $17.06 million. The annualized cost of major maintenance, occurring once every five years, is assumed to be $0.25 million for each refinery.

The annual operating costs include utilities (natural gas, electricity, water, waste water, cooling water, and compressed air), solid waste from catalyst fines, and caustic used. Costs of utilities range from $0.61 to $0.96 million, and the solid waste disposal cost is estimated to be from $0.01 to $0.06 million. The additional caustic usage is estimated at $0.04 to $0.18 million among the four affected refineries. In addition, the total annual maintenance cost at the four refineries is estimated to be $0.62 million. The total recurring cost of compliance for the refinery FCCUs is estimated at $4.24 million.

The total annualized cost of compliance, including capital, operating, and maintenance, is estimated to be $21.3 million.

### Refinery Sulfur Recovery Units

Refineries use a sulfur recovery system to maximize sulfur removal from the crude oil. WGSs and EmeraChem Power LLC (selective oxidation catalyst) are assumed as main control strategies to further reduce SO2 emissions from all the sulfur recovery/tail gas treatment (SRU/TG) units at refineries. WGSs are used to control both SOx and particulate emissions and can be installed on sulfur recovery units/tail gas units. EmeraChem ESx catalyst can capture multiple sulfur species, including $SO_2$, $SO_3$, and $H_2S$. In addition to sulfur capture, the catalyst will destroy CO, VOC, and Particulate

[2] The consultants accounted for salvage values of the control equipment and deducted these values upfront from the values of the control equipment.

matter ($PM_{10}$). It is assumed that two out of the three affected refineries would install three WGSs and the remaining refinery would install an EmeraChem ESx catalyst.

The total compliance cost of the proposed amendments for refinery SRU/TG units includes one-time cost and recurring cost. The one-time cost includes the capital cost of WGSs and EmeraChem ESx catalyst, and their installations (demolition, concrete, structural, piping electrical, contractors, contingencies), and major maintenance services at the five-year interval. The annual costs are additional operating and maintenance costs of those new WGSs and EmeraChem ESx catalyst.

It is assumed that the refineries would install three WGSs and one EmeraChem ESx catalyst on their three affected SRU units. One refinery is expected to install two WGSs. The capital cost of two new WGSs at one refinery is estimated to be $23.2million. The capital cost of one new WGS for the other refinery is estimated to be $14.63 million. The installation cost of those scrubbers is estimated to be $28.10 and 23.18 million, respectively. The capital and installation cost of one EmeraChem ESx catalyst for the third affected refinery is estimated to be $5.14 and $7.53 million, respectively. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the refinery SRU units is estimated at $6.66 million. The annualized cost of major maintenance, occurring once every five years, is estimated to be $0.17 to $0.32 million among the affected refineries.

The annual operating costs include utilities (natural gas, electricity, water, waste water, cooling water, and compressed air), solid waste disposal, and soda ash or sorbent used. The cost of utilities is estimated to be $1.36 and $2.84 million for the two new scrubbers, and $0.18 million for the EmeraChem catalyst. The solid waste disposal cost is estimated at $0.03 to $0.05 for the two new scrubbers. The soda ash or sorbent used by these affected refineries is estimated to be $0.02 million. In addition, the total annual maintenance cost of the three refineries is estimated at $0.14 million. The total recurring cost of compliance for the refinery SRUs is estimated at $4.54 million.

The total annualized cost of compliance, including capital, operating, and maintenance is estimated to be $11.20 million.

### Sulfuric Acid Plants

Sulfuric acid is a chemical product that is used in manufacturing phosphate and nitrogen fertilizers, detergents, paper, and rust removers. It is also used extensively in automobile manufacturing, metal smelting, water treatment and oil refining processes. There are two facilities in the Basin that manufacture sulfuric acid. It is assumed that one of the two sulfuric acid manufacturing facilities would install a WGS and the other would install a Cansolv upgrade to comply with the proposed amendments.

The total compliance cost of the proposed amendments for sulfuric acid plants includes one-time cost and recurring cost. The one-time cost includes the capital cost of a WGS and capital cost of a Cansolv upgrade, and one-time cost of their installations (demolition, concrete, structural, piping, electrical, contractors, and contingencies). The

annual costs are additional operating and maintenance costs of a new WGS and a Cansolv upgrade.

The capital cost of a new WGS and a Cansolv upgrade is estimated to be $2.4, and $0.35 million, respectively. The installation cost of a new WGS and Cansolv upgrade is estimated to be $3.69 and $0.15 million, respectively. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the sulfur acid plants is estimated to be 0.43 million.

The annual operating costs include utilities (electric power, makeup water, makeup caustic, steam usage, waste water treatment), and caustic used. The cost of utilities is estimated to be $0.29 and $0.07 million, for the WGS and Cansolv upgrade, respectively. The caustic usage would cost $0.15 million. In addition, the total annual maintenance cost at the two sulfuric acid plants is estimated to be $0.24 million. The total recurring cost of compliance for the two sulfuric acid plants is estimated at $0.75 million.

The total annualized cost of compliance, including capital, operating, and maintenance is estimated to be $1.18 million.

**Glass Plants**

SOx emissions from a container glass melting furnace are typically controlled by a dry scrubber followed by a dry electrostatic precipitator (ESP) to control particulates. Two glass melting facilities are in the SOx RECLAIM program, but only one of these facilities is currently operating. It is assumed that the glass melting facility would use two WGSs to further control SOx emissions.

The total compliance cost of the proposed amendments for the one affected glass plant includes one-time cost and recurring cost. The one-time cost includes the capital cost of the two new WGSs and their installations (demolition, concrete, structural, piping, electrical, contractors, contingencies), and major maintenance services at the five-year interval. The annual costs are additional operating and maintenance costs of those new scrubbers.

The capital cost of the two new WGSs is estimated to be $0.93 million. The installation cost of those WGSs is estimated to be $0.96 million. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the glass plant is estimated at $0.13 million. The annualized cost of major maintenance, occurring once every five years, is assumed to be $0.01 million.

The annual operating costs include utilities (natural gas, electricity, water, waste water, cooling water, compressed air, solid waste disposal), and caustic used. The cost of utilities is estimated to be $0.18 million, and caustic would cost $0.11 million. The total recurring cost for the one affected glass plant is estimated to be $0.29 million. In addition, the total annual maintenance costs is estimated to be 0.14 million. The total recurring cost of compliance for the affected glass plant is estimated at $0.43 million.

The total annualized cost of compliance, including capital, operating, and maintenance is estimated to be $0.56 million.

### Cement Kilns

SOx emissions from cement kilns and coal-fired boilers are generated from combustion of sulfur in the fuel and oxidation of sulfides (e.g., pyrites) in the raw materials when entering the cement kiln. Fuel switching, process alteration, dry and wet scrubbers are commercially available control technologies for reducing SOx emissions. It is assumed that the operator of the cement plant would install two dry gas scrubbers to further control SOx emissions.

The total compliance cost of the proposed amendments for the one affected cement plant includes one-time cost and recurring cost. The one-time cost includes the capital cost of the two DGSs and their installations (demolition, concrete, structural, piping, electrical, contractors, contingencies), and major maintenance services at the five-year interval. The annual costs are additional operating and maintenance costs of those new scrubbers.

The capital cost of the two new DGSs is estimated to be $13.72 million. The installation cost of those DGSs is estimated to be $5.91 million. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the cement plant is estimated at $1.72 million. The annualized cost of major maintenance, occurring once every five years, is assumed to be $0.5 million.

The annual operating costs include of utilities (natural gas, electricity, water, waste water, cooling water, compressed air), solid waste disposal, and limestone used. The cost of utilities is estimated to be $1.15 million, and the limestone usage would cost $0.06 million. In addition, the total annual maintenance cost is estimated to be $0.32 million. The total recurring cost of compliance for the affected cement plant is estimated at $1.53 million.

The total annualized cost of compliance, including capital, operating, and maintenance is estimated to be $3.25 million.

### Coke Calciners

Petroleum coke, the heaviest portion of crude oil, cannot be recovered in the normal oil refinining process. Instead, it is processed in a delayed coker unit to generate a carbonaceous solid referred to as "green coke." Green coke with low metals content can be sent to a calciner to make calcined petroleum coke. Calcined petroleum coke can be used to make anodes for the aluminum, steel, and titanium smelting industry.

There is only one petroleum coke calciner in the District and the SOx emissions from the unit are controlled by a dry scrubber. It is assumed that operators of the petroleum coke calcining facility would install a WGS to further control SOx emissions in order to comply with the proposed requirements.

The total compliance cost of the proposed amendments for the one affected coke calciner plant includes one-time cost and recurring cost. The one-time cost includes the capital cost of a WGS and its installations (demolition, concrete, structural, piping, electrical, contractors, and contingencies). The recurring costs are additional operating and maintenance costs of the new scrubber.

The capital cost of a new WGS is estimated to be $5.54 million. The installation cost of a new WGS is estimated to be $7.75 million. Assuming a 25-year life for equipment and installation, and a real interest rate of four percent, the total one-time annualized cost of compliance for the coke calciner plant is estimated at $0.85 million.

The annual operating costs include utilities (natural gas, electricity, water, waste water), and caustic usage. The cost of utilities is estimated to be $0.39 million, and the caustic usage would cost $0.1 million. In addition, the total maintenance cost is estimated to be $0.24 million. The total recurring cost of compliance for the affected coke calciner plant is estimated at $ 0.73 million.

The total annualized cost of compliance, including capital, operating, and maintenance is estimated to be $1.58 million.

#### Refinery Boilers and Heaters

Some of the existing boilers/heaters at the refineries currently meet the proposed BARCT limit of 40 ppmv, and as such do not need to install additional SOx control equipment. The affected sources in this category may elect to install SOx control equipment as an opportunity to further reduce emissions which are not due to new BARCT. Staff did not develop cost estimates for this category.

### Cost Based on Input from NEC

NEC provided capital and maintenance costs estimates for each individual facility across the six source categories. Except for one FCCU in a refinery and a glass plant, NEC's estimates were higher values than those from the ETS/NEXIDEA. Table 4 presents cost adjustment factors by equipment by facility relative to the ETS/NEXIDEA cost estimates.

**Table 4**
**Cost Adjustment Factors**
**by Equipment Category**

| Equipment Category | Costs Adjustment Ratio |
|---|---|
| FCCU (Refinery One) | 1.06 |
| FCCU (Refinery Three) | 1.21 |
| FCCU (Refinery Four) | 1.07 |
| FCCU (Refinery Six) | 0.99 |
| SRU (Refinery Two) | 1.27 |
| SRU (Refinery Three) | 4.29 |
| SRU (Refinery Six) | 1.14 |
| Glass (Glass Plant) | 1.00 |
| Cement Plant | 1.42 |
| Sulfuric Acid Plant (at the Refinery) | 1.63 |
| Sulfuric Acid Plant | 1.72 |
| Coke Calciner Plant | 2.38 |

Table 5 shows the average annual cost of the proposed amendments by equipment. The total average annual cost of the proposed amendments is estimated at $42 million between 2011 and 2030. The majority of the compliance cost ($36 million or 86 percent) is expected to incur in the sector of petroleum product manufacturing where the six affected refineries belong. Refinery FCCU units would face the highest compliance cost of $18.8 million (43 percent of the total cost).

**Table 5**
**Average Annual Cost Based on NEC's input**
**by Equipment Category (millions of 2010 dollars)**

| Equipment Category | 2011 | 2014 | 2019 | 2030 | Average Annual (2011-2030) |
|---|---|---|---|---|---|
| Refinery FCCU Units | $1.92 | $12.37 | $22.80 | $22.80 | $18.80 |
| Refinery Sulfur Recovery Units | $0.00 | $7.30 | $16.94 | $16.94 | $13.64 |
| Coke Calciner | $1.01 | $3.77 | $3.77 | $3.77 | $3.54 |
| Sulfur Acid Plant (at Refinery) | $0.05 | $0.17 | $0.17 | $0.17 | $0.16 |
| Cement Plant | $0.87 | $4.00 | $4.00 | $4.00 | $3.73 |
| Glass Plant | $0.00 | $0.57 | $0.57 | $0.57 | $0.52 |
| Sulfur Acid Plant | $0.36 | $1.90 | $1.90 | $1.90 | $1.77 |
| | | | | | |
| **Total** | **$4.21** | **$30.08** | **$50.15** | **$50.15** | **$42.16** |

## EMPLOYMENT AND REGIONAL ECONOMIC IMPACTS

The REMI model (Policy Insight version V.1.1.6) is used to assess the total socioeconomic impacts of a policy change. The model links the economic activities in

the counties of Los Angeles, Orange, Riverside, and San Bernardino. The REMI model for each county is comprised of a five block structure that includes (1) output and demand, (2) labor and capital, (3) population and labor force, (4) wages, prices and costs, and (5) market shares. These five blocks are interrelated. Within each county, producers are made up of 66 private non-farm industries, three government sectors, and a farm sector. Trade flows are captured between sectors and borders as well as across counties and the rest of U.S. Market shares of industries are dependent upon their product prices, access to production inputs, and local infrastructure. The demographic/migration component has 160 ages/gender/race/ethnicity cohorts and captures population changes in births, deaths, and migration.

The assessment herein is performed relative to a baseline without the proposed amendments. Direct effects of the policy change (proposed amendments and CEQA alternatives) have to be estimated and used as inputs to the REMI model in order for the model to assess secondary and induced impacts for all the actors in the four-county economy on an annual basis and across a user-defined horizon (2011-2030). Direct effects of the proposed amendments and CEQA alternatives include additional costs of the proposed requirements to the affected industries and additional goods and services provided by local vendors at the county (or finer) level and by industry. Indirect effects are changes in inter-industry transactions as local suppliers (e.g., construction and miscellaneous professional services) respond to increased demands from directly affected industries (refineries, sulfur acid plans, cement kilns, glass plants). Induced effects reflect changes in local spending that result from personal income changes due to direct and indirect effects.

Refineries, sulfur acid plants, glass plants, and cement plants will face an additional cost of doing business from purchasing new WGSs, DGS, EmeraChem ESx catalyst, and Cansolv upgrade. All the equipment is produced outside of the District and the local economy would thus only benefit from the additional spending on demolition, installation, and operating and maintenance of the new SOx control equipment. The major beneficiaries are the sectors of construction (NAICS 23), miscellaneous professional services (NAICS 54), and utilities (NAICS 22).

Additional costs of doing business to the affected facilities include the annualized capital cost and annual operating and maintenance costs of WGSs, DGSs, EmeraChem ESx catalyst, and Cansolv upgrade. Expenditures on labor are treated as a reduction in labor productivity because more labor will now be required to produce the same amount of output in an industry affected by the proposed amendments.

**Employment Impact Based on ETS/NEXIDEA Cost Estimates**

The total employment impact of the proposed amendments across industries in key years is shown in Table 6. It is projected that an average of two jobs could be forgone annually from 2011 to 2030 in the local economy. The minor jobs forgone would fall within the noise of the REMI Model.

Equipment installation to ensure compliance with the proposed amendments is assumed to start in the year 2011 and continue through 2019. In earlier years, the positive job

impact from the expenditures made by refineries, glass, cement and sulfur acid plants would more than offset the jobs forgone from the additional cost of doing business (Table 6). In 2011, 496 additional jobs could be created in the overall economy. The positive job impact would trickle down to the sectors of construction, miscellaneous professional services, retail, wholesale, and business services. However, as refineries, glass, cement, and sulfur acid plants continue to amortize their capital expenditures in earlier years, reductions in job growth would set in, resulting in jobs forgone in later years. Please refer to Appendix A for more details.

The three affected industries where refineries, glass, cement, and sulfur acid plants belong are projected to have one to 13 jobs forgone per year, on average, from 2011 to 2030. Despite having a large share of the total compliance cost, the refinery industry is projected to have fewer jobs forgone relative to other industries with similar magnitude of cost impact due to the fact that the industry is the most capital-intensive. As such, fewer labor would be required to produce the same amount of products or services.

The reduction in disposable income from the overall jobs forgone dampens the demand for goods and services in the local economy, thus resulting in jobs forgone in other sectors such as the rest of manufacturing, retail trade, wholesale, and accommodation and food services.

**Table 6**
**Job Impacts of ETS/NEXIDEA cost Estimates by Industry by Year**

| Industry | NAICS | Year | | | | Average Annual (2011-2030) |
|---|---|---|---|---|---|---|
| | | 2011 | 2014 | 2019 | 2030 | |
| Oil and gas extraction | 211 | 0 | -1 | -5 | -5 | -4 |
| Utilities | 22 | 1 | 3 | 7 | 6 | 6 |
| Construction | 23 | 228 | 250 | -33 | -16 | 73 |
| Nonmetallic mineral product mfg. | 327 | 1 | -6 | -16 | -18 | -13 |
| Fabricated metal product mfg. | 332 | 5 | 4 | -2 | -1 | 0 |
| Petroleum and coal product mfg. | 324 | 0 | -2 | -5 | -5 | -4 |
| Chemical mfg. | 325 | 1 | 0 | -2 | -2 | -1 |
| Rest of Manufacturing | 31-33 | 10 | 3 | -12 | -5 | -4 |
| Wholesale trade | 42 | 12 | 6 | -13 | -8 | -4 |
| Retail trade | 44-45 | 34 | 20 | -35 | -28 | -12 |
| Truck transportation and couriers | 484,492 | 5 | 3 | -6 | -5 | -2 |
| Monetary authorities | 521,522,525 | 8 | 4 | -7 | -3 | -2 |
| Securities, and commodity contracts | 523 | 7 | 4 | -7 | -2 | -1 |
| Insurance carriers and related activities | 524 | 3 | 1 | -3 | -2 | -1 |
| Real estate | 531 | 11 | 5 | -16 | -15 | -8 |
| Professional and technical services | 54 | 31 | 34 | -14 | -13 | 3 |
| Management of companies and enterprises | 55 | 2 | 1 | -4 | -2 | -2 |
| Administrative and support services | 561 | 24 | 19 | -19 | -14 | -4 |
| Waste management and remediation services | 562 | 1 | 1 | 0 | 1 | 1 |
| Educational services | 61 | 4 | 5 | -3 | -5 | -1 |
| Ambulatory health care services | 621 | 18 | 11 | -16 | -7 | -3 |
| Hospitals | 622 | 3 | 4 | -1 | -3 | 0 |
| Nursing and residential care facilities | 623 | 2 | 3 | -1 | -3 | 0 |
| Social assistance | 624 | 4 | 5 | -1 | -5 | 0 |
| Performing arts and spectator sports | 711 | 2 | 0 | -3 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 2 | 2 | -1 | -3 | -1 |
| Accommodation | 721 | 2 | 1 | -2 | -1 | -1 |
| Food services and drinking places | 722 | 11 | 13 | -5 | -10 | -1 |
| Repair and maintenance | 811 | 5 | 4 | -3 | -4 | -1 |
| Personal and laundry services | 812 | 7 | 4 | -7 | -2 | -1 |
| Membership associations and organization | 813 | 3 | 3 | -2 | -3 | -1 |
| Private households | 814 | 6 | 3 | -5 | -2 | -1 |
| Other Industries | | 8 | 4 | -10 | -6 | -3 |
| Government | | 34 | 27 | -24 | -29 | -8 |
| | | | | | | |
| **Total** | | **496** | **435** | **-276** | **-218** | **-2** |

The job impacts include all the companies (affected and unaffected by the proposed amendments) in the respective industries.

### Employment Impact Based on NEC Input

The total employment impact of the proposed amendments across industries in key years is shown in Table 7. It is projected that an average of 9 jobs could be forgone annually from 2011 to 2030 in the local economy.

Compliance with the proposed amendments is assumed to start in the year 2011 and continue through 2019. In earlier years, the positive job impact from the expenditures

made by refineries, glass, cement and sulfur acid plants would more than offset the jobs forgone from the additional cost of doing business (Table 7). In 2011, 646 additional jobs could be created in the overall economy. The positive job impact would trickle down to the sectors of construction, miscellaneous professional services, retail, wholesale, and business services. However, as refineries, glass, cement, and sulfur acid plants continue to amortize their capital expenditures in earlier years, reductions in job growth would set in, resulting in fewer jobs created in later years.

The three affected industries where refineries, glass, cement, and sulfur acid plants belong are projected to have two to 18 jobs forgone per year from 2011 to 2030. Despite having a large share of the total compliance cost, the refinery industry would have fewer jobs forgone relative to other industries with similar magnitude of cost impact due to the fact that the industry is the most capital-intensive. As such, fewer labor would be required to produce the same amount of products or services.

**Table 7**
**Job Impacts from NEC Input by Industry by Year**

| Industry | NAICS | Year | | | | Average Annual (2011-2030) |
|---|---|---|---|---|---|---|
| | | 2011 | 2014 | 2019 | 2030 | |
| Oil and gas extraction | 211 | 0 | -2 | -6 | -6 | -5 |
| Utilities | 22 | 1 | 4 | 9 | 8 | 7 |
| Construction | 23 | 298 | 286 | -36 | -16 | 87 |
| Nonmetallic mineral product mfg. | 327 | 2 | -9 | -22 | -24 | -18 |
| Fabricated metal product mfg. | 332 | 7 | 5 | -3 | -1 | 0 |
| Petroleum and coal product mfg. | 324 | 0 | -3 | -6 | -6 | -5 |
| Chemical mfg. | 325 | 1 | 0 | -3 | -3 | -2 |
| Rest of Manufacturing | 31-33 | 13 | 3 | -15 | -6 | -5 |
| Wholesale trade | 42 | 16 | 7 | -16 | -10 | -6 |
| Retail trade | 44-45 | 44 | 21 | -43 | -35 | -16 |
| Truck transportation and couriers | 484,492 | 7 | 4 | -7 | -6 | -3 |
| Monetary authorities | 521,522,525 | 10 | 4 | -9 | -4 | -2 |
| Securities, and commodity contracts | 523 | 9 | 4 | -9 | -2 | -2 |
| Insurance carriers and related activities | 524 | 4 | 1 | -4 | -2 | -1 |
| Real estate | 531 | 14 | 4 | -20 | -19 | -11 |
| Professional and technical services | 54 | 40 | 48 | -9 | -10 | 10 |
| Management of companies and enterprises | 55 | 3 | 1 | -5 | -3 | -2 |
| Administrative and support services | 561 | 32 | 22 | -23 | -17 | -5 |
| Waste management and remediation services | 562 | 1 | 1 | 1 | 1 | 1 |
| Educational services | 61 | 5 | 5 | -3 | -7 | -1 |
| Ambulatory health care services | 621 | 24 | 12 | -19 | -9 | -4 |
| Hospitals | 622 | 4 | 4 | -1 | -4 | 0 |
| Nursing and residential care facilities | 623 | 3 | 3 | -1 | -4 | -1 |
| Social assistance | 624 | 5 | 6 | -2 | -7 | -1 |
| Performing arts and spectator sports | 711 | 2 | 0 | -3 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 3 | 2 | -2 | -4 | -1 |
| Accommodation | 721 | 2 | 1 | -2 | -2 | -1 |
| Food services and drinking places | 722 | 15 | 14 | -6 | -13 | -2 |
| Repair and maintenance | 811 | 6 | 5 | -4 | -5 | -1 |
| Personal and laundry services | 812 | 9 | 4 | -8 | -3 | -1 |
| Membership associations and organization | 813 | 4 | 4 | -2 | -5 | -1 |
| Private households | 814 | 8 | 4 | -6 | -3 | -1 |
| Other Industries | | 11 | 5 | -13 | -7 | -4 |
| Government | | 44 | 30 | -31 | -37 | -11 |
| | | | | | | |
| **Total** | | **646** | **500** | **-329** | **-271** | **-9** |

The job impacts include all the companies (affected and unaffected by the proposed amendments) in the respective industries.

### Competitiveness Based on ETS/NEXIDEA Cost Estimates

The additional cost brought on by the proposed amendments would increase the cost of production of the affected industries relative to their national counterparts. Changes in relative production costs would thus be a good indicator of changes in relative competitiveness. The magnitude of the impact depends on the size and diversification of, and infrastructure in a local economy as well as interactions among industries. A large,

diversified, and resourceful economy would absorb the impact with relative ease. Implementation of the proposed amendments would increase the cost of doing business for affected industries.

An index of 0 indicates that there is no change in the cost of production relative to the rest of the United States. An index of above or below 0 means that the cost of production in the four-county areas resulting from the proposed amendments is higher or lower, respectively, than that in the rest of the United States.

Table 8 shows the impact of the proposed amendments on the cost of production by the affected industries and for selected years. The sector of petroleum and coal product manufacturing would experience the largest increase in the relative cost of production (e.g., 0.09 percent in 2014). In 2019, the relative cost of production in this sector would increase to 0.18 percent.

Changes in production costs will affect prices of goods produced locally. The relative delivered price of a good is based on its production cost and the transportation cost of delivering the good to where it is consumed or used. The average price of a good at the place of use reflects prices of the good produced locally and imported elsewhere.

Based on the measurement of relative delivered prices in the REMI model, the proposed amended rule is projected to result in higher delivered prices. These impacts are similar to those on the relative cost of production. For example, the sector of petroleum and coal product manufacturing would experience an increase in relative delivered prices of 0.12 percent in 2019 (Table 8), while other industries will experience minimal increases in relative delivered prices after 2014.

**Table 8**
**Impacts on Relative Cost of Production and Delivered Prices Based on ETS/NEXIDEA Estimates (Relative to the U.S.)**

| Industry | Relative Cost of Production | | | Relative Delivered Price | | |
|---|---|---|---|---|---|---|
| | 2014 | 2019 | 2030 | 2014 | 2019 | 2030 |
| Utilities | 0.0023% | 0.0015% | 0.0003% | 0.0021% | 0.0013% | 0.0002% |
| Construction | 0.0027% | 0.0019% | 0.0012% | 0.0027% | 0.0018% | 0.0011% |
| Petroleum and Coal Product Manufacturing | 0.0895% | 0.1779% | 0.1660% | 0.0626% | 0.1240% | 0.1144% |
| Non-Metallic Mineral Product Manufacturing | 0.0726% | 0.0670% | 0.0530% | 0.0373% | 0.0345% | 0.0278% |
| Chemical Manufacturing | 0.0064% | 0.0053% | 0.0040% | 0.0036% | 0.0029% | 0.0022% |

### Competitiveness Based on NEC Input

Table 9 shows the impact of the proposed amendments on the cost of production by the affected industries and for selected years. The sector of petroleum and coal product manufacturing would experience the largest increase in the relative cost of production (e.g., 0.11 percent in 2014). In 2019, the relative cost of production in this sector would increase to 0.21 percent.

Based on the measurement of relative delivered prices in the REMI model, the proposed amended rule is projected to result in higher delivered prices. These impacts are similar to those on the relative cost of production. For example, the petroleum and coal product manufacturing sector would experience an increase (0.15 percent) in relative delivered prices in 2019 (Table 9), while other industries will experience minimal increase in relative delivered prices.

**Table 9**
**Impacts of Relative Cost of Production and Delivered Prices Based on NEC's Input (Relative to the U.S.)**

| Industry | Relative Cost of Production | | | Relative Delivered Price | | |
|---|---|---|---|---|---|---|
| | 2014 | 2019 | 2030 | 2014 | 2019 | 2030 |
| Utilities | 0.0030% | 0.0020% | 0.0000% | 0.0025% | 0.0016% | 0.0003% |
| Construction | 0.0030% | 0.0020% | 0.0020% | 0.0035% | 0.0025% | 0.0016% |
| Petroleum and Coal Product Manufacturing | 0.1130% | 0.2140% | 0.1970% | 0.0787% | 0.1491% | 0.1360% |
| Non-Metallic Mineral Product Manufacturing | 0.0980% | 0.0910% | 0.0720% | 0.0498% | 0.0462% | 0.0373% |
| Chemical Manufacturing | 0.0100% | 0.0090% | 0.0070% | 0.0058% | 0.0050% | 0.0038% |

## CEQA ALTERNATIVES

Staff has identified three alternatives to the proposed amendments, as outlined in the Environmental Assessment prepared pursuant to the California Environmental Quality Act (CEQA). Alternative A, the No Project Alternative, is the existing SOx RECLAIM program. Alternative B is Control Measure CMB-02 (Further SOx Reduction for RECLAIM SOx) in the 2007 AQMP. This alternative seeks SOx emission reductions from the top three most cost-effective controls on equipment/source categories, i.e., sulfuric acid manufacturing, coke calciner, and glass melting furnaces. Alternative C would impose the same SOx limits on fewer equipment/source categories when compared to the proposed project. Specifically, this alternative would exclude the sulfur recovery category.

Table 10 presents a comparison of the alternatives in terms of annual average cost and jobs forgone. Alternative A serves as a benchmark against which other alternatives were evaluated. Of the three remaining alternatives, the proposed project has the highest cost and the lowest jobs forgone. Alternative B has the lowest cost ($3.14 million) because fewest source categories would be regulated. This alternative would result in an average of 29 jobs forgone annually. This alternative excludes controls on FCCU and SRU units at refineries and hence would exclude potential jobs that could have been created due to additional expenditure on these controls. Alternative C ($23.40 million) would cost less than the proposed amendments and yet has the highest jobs forgone annually. Both Alternatives B and C would have more jobs forgone than the proposed amendments.

**Table 10**
**Average Annual Impacts of CEQA Alternatives**

| Alternative | Cost (in millions) | Job Impact |
|---|---|---|
| Proposed Amendments* | $32.24 | -2 |
| Alternative A | 0 | 0 |
| Alternative B | $3.14 | -29 |
| Alternative C | $23.40 | -37 |

*Based on ETS/NEXIDEA Cost Estimates

## RULE ADOPTION RELATIVE TO THE COST-EFFECTIVENESS

On October 14, 1994, the Governing Board adopted a resolution that requires staff to address whether rules being proposed for adoption are considered in the order of cost-effectiveness. The 2007 Air Quality Management Plan (AQMP) ranked, in the order of cost-effectiveness, all of the proposed control measures for which costs were quantified. It is generally recommended that the most cost-effective actions be taken first.

The proposed amendments are part of Control Measure CMB-02 (Further SOx Reduction for RECLAIM SOx). It was indicated in the 2007 AQMP that implementation of this control measure would require consideration of facility modernization, as described under Control Measure MCS-01 (Facility Modernization).

Control Measure CMB-02 was ranked 8$^{th}$ with cost-effectiveness from $10,100 to $16,000 per ton of SOx reduced, and Control Measure MSC-01 was ranked 9$^{th}$ with cost-effectiveness of $19,000 per ton of PM2.5 reduced. Cost-effectiveness of the proposed amendments is estimated at $16,000 to $19,000 per ton of SOx (equivalent to $10,700 to $12,700 per ton of PM2.5) reduced and is within the ranking order of cost-effectiveness in the 2007 AQMP.

## IMPACTS OF WSPA SCENARIO

Western States Petroleum Association (WSPA) requested an analysis of its scenario, which includes additional costs of compliance in the FCCU and sulfur recovery units (SRU) units. Based on the WSPA estimates, the compliance costs of WGSs for FCCU and SRU units are three times higher than what the ETS, Inc. and NEXIDEA Inc. had provided to the District staff. The costs of the proposed amendments for other categories of equipment are unchanged.

### Cost Impact

Table 11 presents the estimated average annual cost of the proposed amendments by equipment. Under the WSPA scenario, the average annual cost of the proposed amendments is estimated at $85.2 million between 2011 and 2030. The majority of the compliance cost ($81 million or 95 percent) is expected to incur in the sector of petroleum product manufacturing where the six affected refineries belong. Refinery

FCCU units would face the highest compliance cost of $52.9 million (62 percent of the total cost).

**Table 11**
**Average Annual Cost of WSPA Scenario**
**by Equipment Category (millions of 2010 dollars)**

| Equipment Category | 2011 | 2014 | 2019 | 2030 | Average Annual (2011-2030) |
|---|---|---|---|---|---|
| Refinery FCCU Units | $5.79 | $35.86 | $63.89 | $63.89 | $52.94 |
| Refinery Sulfur Recovery Units | $0.00 | $9.92 | $33.91 | $33.91 | $26.49 |
| Coke Calciner | $0.43 | $1.59 | $1.59 | $1.59 | $1.49 |
| Sulfur Acid Plant (at Refinery) | $0.03 | $0.10 | $0.10 | $0.10 | $0.10 |
| Cement Plant | $0.61 | $2.81 | $2.81 | $2.81 | $2.62 |
| Glass Plant | $0.00 | $0.57 | $0.57 | $0.57 | $0.52 |
| Sulfur Acid Plant | $0.21 | $1.11 | $1.11 | $1.11 | $1.03 |
| | | | | | |
| **Total** | **$7.07** | **$51.96** | **$103.98** | **$103.98** | **$85.19** |

## Employment Impact

The total employment impact of the proposed amendments across industries in key years is shown in Table 12. It is projected that an average of 202 jobs could be created annually from 2011 to 2030 in the local economy.

Compliance with the proposed amendments is assumed to start in the year 2011 and continue through 2019. In earlier years, the positive job impact from the expenditures made by refineries, glass, cement and sulfur acid plants would more than offset the jobs forgone from the additional cost of doing business (Table 12). In 2011, 1,161 additional jobs could be created in the overall economy. The positive job impact would trickle down to the sectors of construction, miscellaneous professional services, retail, wholesale, and business services. However, as refineries, glass, cement, and sulfur acid plants continue to amortize their capital expenditures in earlier years, reductions in job growth would set in, resulting in fewer jobs created in later years.

The three affected industries where refineries, glass, cement, and sulfur acid plants belong are projected to have one to 12 jobs forgone per year from 2011 to 2030. Despite having a large share of the total compliance cost, the refinery industry would have fewer jobs forgone relative to other industries with similar magnitude of cost impact due to the fact that the industry is the most capital-intensive. As such, fewer labor would be required to produce the same amount of products or services.

The reduction in disposable income from the overall jobs forgone dampens the demand for goods and services in the local economy, thus resulting in jobs forgone in other sectors such as the rest of manufacturing, retail trade, wholesale, and accommodation and food services.

**Table 12**
**Job Impacts of WSPA by Industry by Year**

| Industry | NAICS | Year | | | | Average Annual (2011-2030) |
|---|---|---|---|---|---|---|
| | | 2011 | 2014 | 2019 | 2030 | |
| Oil and gas extraction | 211 | 0 | -4 | -15 | -13 | -11 |
| Utilities | 22 | 1 | 6 | 19 | 16 | 14 |
| Construction | 23 | 528 | 769 | -68 | -29 | 225 |
| Nonmetallic mineral product mfg. | 327 | 4 | -2 | -17 | -18 | -12 |
| Fabricated metal product mfg. | 332 | 12 | 14 | -5 | -2 | 3 |
| Petroleum and coal product mfg. | 324 | 0 | -4 | -13 | -13 | -11 |
| Chemical mfg. | 325 | 2 | 2 | -3 | -2 | -1 |
| Rest of Manufacturing | 31-33 | 24 | 18 | -25 | -7 | -3 |
| Wholesale trade | 42 | 29 | 27 | -29 | -15 | -6 |
| Retail trade | 44-45 | 81 | 82 | -76 | -54 | -14 |
| Truck transportation and couriers | 484,492 | 12 | 14 | -12 | -9 | -2 |
| Monetary authorities | 521,522,525 | 18 | 16 | -16 | -5 | -1 |
| Securities, and commodity contracts | 523 | 16 | 14 | -18 | -3 | -1 |
| Insurance carriers and related activities | 524 | 6 | 5 | -8 | -3 | -1 |
| Real estate | 531 | 26 | 26 | -27 | -21 | -6 |
| Professional and technical services | 54 | 73 | 112 | -23 | -18 | 21 |
| Management of companies and enterprises | 55 | 6 | 4 | -9 | -4 | -3 |
| Administrative and support services | 561 | 57 | 69 | -40 | -25 | 2 |
| Waste management and remediation services | 562 | 1 | 2 | 1 | 1 | 2 |
| Educational services | 61 | 10 | 16 | -4 | -8 | 1 |
| Ambulatory health care services | 621 | 44 | 43 | -37 | -11 | 1 |
| Hospitals | 622 | 7 | 12 | 0 | -5 | 2 |
| Nursing and residential care facilities | 623 | 5 | 9 | -1 | -4 | 1 |
| Social assistance | 624 | 9 | 16 | 0 | -8 | 2 |
| Performing arts and spectator sports | 711 | 4 | 2 | -6 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 5 | 8 | -2 | -5 | 1 |
| Accommodation | 721 | 4 | 4 | -3 | -2 | 0 |
| Food services and drinking places | 722 | 27 | 42 | -5 | -17 | 6 |
| Repair and maintenance | 811 | 12 | 15 | -6 | -6 | 1 |
| Personal and laundry services | 812 | 17 | 15 | -15 | -3 | 0 |
| Membership associations and organization | 813 | 7 | 10 | -2 | -5 | 1 |
| Private households | 814 | 15 | 13 | -12 | -5 | 0 |
| Other Industries | | 20 | 18 | -24 | -11 | -5 |
| Government | | 78 | 96 | -42 | -51 | 0 |
| | | | | | | |
| **Total** | | **1,162** | **1,490** | **-542** | **-364** | **202** |

The job impacts include all the companies (affected and unaffected by the proposed amendments) in the respective industries.

## Competitiveness Impact

Table 13 shows the impact of the proposed amendments on the cost of production by the affected industries and for selected years. The sector of petroleum and coal product manufacturing would experience the largest increase in the relative cost of production (e.g., 0.25 percent in 2014). In 2019, the relative cost of production in this sector would increase to 0.51 percent.

Based on the measurement of relative delivered prices in the REMI model, the proposed amended rule is projected to result in higher delivered prices. These impacts are similar to those on the relative cost of production. For example, the petroleum and coal product manufacturing sector would experience an increase (0.36 percent) in relative delivered prices in 2019 (Table 13), while other industries will experience minimal increase in relative delivered prices.

**Table 13**
**Impacts of WSPA Relative Cost of Production and Delivered Prices**
**(Relative to the U.S.)**

| Industry | Relative Cost of Production | | | Relative Delivered Price | | |
|---|---|---|---|---|---|---|
| | 2014 | 2019 | 2030 | 2014 | 2019 | 2030 |
| Utilities | 0.0060% | 0.0040% | 0.0000% | 0.0052% | 0.0033% | 0.0003% |
| Construction | 0.0050% | 0.0030% | 0.0010% | 0.0048% | 0.0028% | 0.0010% |
| Petroleum and Coal Product Manufacturing | 0.2510% | 0.5170% | 0.4820% | 0.1753% | 0.3598% | 0.3322% |
| Non-Metallic Mineral Product Manufacturing | 0.0740% | 0.0670% | 0.0530% | 0.0379% | 0.0347% | 0.0277% |
| Chemical Manufacturing | 0.0080% | 0.0060% | 0.0040% | 0.0044% | 0.0033% | 0.0021% |

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# APPENDIX A
# Job Impacts by Scenario

## Table A-1: Annual Job Impacts Based on of ETS/NEXIDEA

| Category | NAICS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and gas extraction | 211 | 0 | 0 | -1 | -1 | -2 | -3 | -4 | -5 | -5 | -5 | -6 | -6 | -6 | -6 | -6 | -5 | -5 | -5 | -5 | -5 | -4 |
| Utilities | 22 | 1 | 1 | 3 | 3 | 4 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 |
| Construction | 23 | 228 | 335 | 325 | 250 | 208 | 222 | 139 | 70 | -33 | -35 | -34 | -33 | -30 | -27 | -25 | -23 | -20 | -18 | -17 | -16 | 73 |
| Nonmetallic mineral product manufacturing | 327 | 1 | 1 | -2 | -6 | -9 | -11 | -13 | -14 | -16 | -17 | -17 | -18 | -18 | -18 | -18 | -18 | -18 | -18 | -18 | -18 | -13 |
| Fabricated metal product manufacturing | 332 | 5 | 7 | 6 | 4 | 3 | 3 | 1 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | 0 |
| Petroleum and coal product manufacturing | 324 | 0 | 0 | -1 | -2 | -2 | -3 | -4 | -4 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -4 |
| Chemical manufacturing | 325 | 1 | 1 | 0 | 0 | -1 | -1 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -1 |
| Rest of manufacturing | 31-33 | 10 | 13 | 9 | 3 | -1 | -1 | -5 | -8 | -12 | -11 | -10 | -9 | -8 | -8 | -7 | -6 | -6 | -5 | -5 | -5 | -4 |
| Wholesale trade | 42 | 12 | 16 | 13 | 6 | 2 | 1 | -4 | -8 | -13 | -13 | -13 | -12 | -11 | -10 | -10 | -9 | -9 | -8 | -8 | -8 | -4 |
| Retail trade | 44-45 | 34 | 46 | 36 | 20 | 10 | 8 | -7 | -19 | -35 | -35 | -35 | -34 | -33 | -32 | -31 | -30 | -29 | -28 | -27 | -28 | -12 |
| Truck transportation | 484,492 | 5 | 7 | 6 | 3 | 2 | 2 | -1 | -3 | -6 | -6 | -6 | -6 | -6 | -6 | -5 | -5 | -5 | -5 | -5 | -5 | -2 |
| Monetary authorities | 521,522-525 | 8 | 10 | 8 | 4 | 2 | 1 | -2 | -4 | -7 | -7 | -6 | -6 | -5 | -5 | -4 | -4 | -4 | -3 | -3 | -3 | -2 |
| Securities and investments | 523 | 7 | 9 | 7 | 4 | 1 | 1 | -2 | -4 | -7 | -7 | -6 | -5 | -4 | -4 | -3 | -3 | -2 | -2 | -2 | -2 | -1 |
| Insurance carriers and related activities | 524 | 3 | 3 | 3 | 1 | 0 | 0 | -1 | -2 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -2 | -1 |
| Real estate | 531 | 11 | 14 | 10 | 5 | 0 | 0 | -6 | -10 | -16 | -16 | -16 | -16 | -16 | -15 | -15 | -15 | -15 | -14 | -14 | -15 | -8 |
| Professional and technical services | 54 | 31 | 47 | 50 | 34 | 26 | 25 | 12 | 4 | -14 | -18 | -19 | -18 | -13 | -14 | -16 | -15 | -14 | -10 | -12 | -13 | 3 |
| Management of companies and enterprises | 55 | 2 | 3 | 2 | 1 | 0 | -1 | -2 | -3 | -4 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 |
| Administrative and support services | 561 | 24 | 34 | 30 | 19 | 12 | 12 | 1 | -7 | -19 | -20 | -20 | -19 | -18 | -17 | -17 | -16 | -15 | -14 | -14 | -14 | -4 |
| Waste management | 562 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Educational services | 61 | 4 | 6 | 6 | 5 | 4 | 4 | 2 | 0 | -3 | -3 | -4 | -4 | -4 | -4 | -4 | -5 | -5 | -5 | -5 | -5 | -1 |
| Ambulatory health care services | 621 | 18 | 24 | 20 | 11 | 6 | 6 | -2 | -8 | -16 | -15 | -14 | -13 | -12 | -11 | -10 | -9 | -9 | -8 | -7 | -7 | -3 |
| Hospitals | 622 | 3 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | -1 | -1 | -2 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | 0 |
| Nursing and residential care facilities | 623 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 0 | -1 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -3 | -3 | 0 |
| Social assistance | 624 | 4 | 6 | 6 | 5 | 4 | 4 | 3 | 1 | -1 | -2 | -2 | -3 | -3 | -3 | -3 | -4 | -4 | -4 | -5 | -5 | 0 |
| Performing arts and spectator sports | 711 | 2 | 2 | 1 | 0 | -1 | -1 | -2 | -2 | -3 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 0 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -1 |
| Accommodation | 721 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| Food services and drinking places | 722 | 11 | 17 | 16 | 13 | 10 | 10 | 5 | 1 | -5 | -6 | -7 | -8 | -8 | -9 | -9 | -10 | -10 | -10 | -10 | -10 | -1 |
| Repair and maintenance | 811 | 5 | 7 | 6 | 4 | 3 | 3 | 1 | -1 | -3 | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -4 | -1 |
| Personal and laundry services | 812 | 7 | 9 | 7 | 4 | 2 | 2 | -2 | -4 | -7 | -6 | -6 | -5 | -4 | -4 | -4 | -3 | -3 | -3 | -2 | -2 | -1 |
| Membership associations and organizations | 813 | 3 | 4 | 4 | 3 | 2 | 2 | 1 | 0 | -2 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -1 |
| Private households | 814 | 6 | 8 | 7 | 3 | 2 | 2 | -1 | -3 | -5 | -5 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -1 |
| Other Industries | | 8 | 11 | 9 | 4 | 1 | 1 | -3 | -7 | -10 | -10 | -10 | -9 | -9 | -8 | -7 | -7 | -6 | -6 | -6 | -6 | -3 |
| State and Local | | 34 | 47 | 41 | 27 | 17 | 16 | 2 | -9 | -24 | -27 | -28 | -29 | -29 | -29 | -29 | -29 | -28 | -28 | -28 | -29 | -8 |
| **Total** | | **496** | **703** | **641** | **435** | **312** | **318** | **114** | **-42** | **-276** | **-285** | **-285** | **-277** | **-260** | **-253** | **-247** | **-239** | **-230** | **-218** | **-215** | **-218** | **-2** |

## Table A-2: Annual Job Impacts Based on NEC Input

| Category | NAICS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and gas extraction | 211 | 0 | 0 | -1 | -2 | -3 | -4 | -5 | -6 | -6 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -6 | -6 | -6 | -6 | -5 |
| Utilities | 22 | 1 | 1 | 4 | 4 | 5 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 |
| Construction | 23 | 298 | 411 | 341 | 286 | 253 | 262 | 161 | 74 | -36 | -39 | -39 | -37 | -33 | -30 | -28 | -25 | -22 | -20 | -18 | -16 | 87 |
| Nonmetallic mineral product manufacturing | 327 | 2 | 1 | -4 | -9 | -12 | -15 | -18 | -20 | -22 | -23 | -24 | -24 | -24 | -24 | -25 | -25 | -25 | -24 | -24 | -24 | -18 |
| Fabricated metal product manufacturing | 332 | 7 | 9 | 6 | 5 | 3 | 3 | 1 | -1 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -1 | -1 | 0 |
| Petroleum and coal product manufacturing | 324 | 0 | 0 | -1 | -3 | -3 | -4 | -5 | -6 | -6 | -6 | -7 | -7 | -7 | -7 | -7 | -6 | -6 | -6 | -6 | -6 | -5 |
| Chemical manufacturing | 325 | 1 | 1 | 0 | 0 | -1 | -2 | -2 | -3 | -3 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -2 |
| Rest of manufacturing | 31-33 | 13 | 15 | 8 | 3 | -1 | -3 | -7 | -11 | -15 | -14 | -13 | -12 | -11 | -10 | -9 | -8 | -8 | -7 | -7 | -6 | -5 |
| Wholesale trade | 42 | 16 | 20 | 12 | 7 | 2 | 1 | -6 | -11 | -16 | -16 | -16 | -15 | -14 | -13 | -13 | -12 | -11 | -11 | -10 | -10 | -6 |
| Retail trade | 44-45 | 44 | 57 | 35 | 21 | 11 | 8 | -11 | -26 | -43 | -44 | -43 | -42 | -40 | -39 | -39 | -37 | -36 | -35 | -34 | -35 | -16 |
| Truck transportation | 484,492 | 7 | 9 | 6 | 4 | 2 | 1 | -2 | -4 | -7 | -7 | -8 | -7 | -7 | -7 | -7 | -7 | -7 | -6 | -6 | -6 | -3 |
| Monetary authorities | 521,522-525 | 10 | 12 | 8 | 4 | 2 | 1 | -3 | -5 | -9 | -8 | -8 | -7 | -6 | -6 | -5 | -5 | -5 | -4 | -4 | -4 | -2 |
| Securities and investments | 523 | 9 | 11 | 7 | 4 | 2 | 1 | -3 | -6 | -9 | -8 | -7 | -6 | -5 | -4 | -4 | -3 | -3 | -3 | -2 | -2 | -2 |
| Insurance carriers and related activities | 524 | 4 | 4 | 2 | 1 | 0 | 0 | -2 | -3 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -1 |
| Real estate | 531 | 14 | 18 | 10 | 4 | 0 | -2 | -8 | -14 | -20 | -21 | -21 | -21 | -20 | -20 | -20 | -19 | -19 | -19 | -19 | -19 | -11 |
| Professional and technical services | 54 | 40 | 68 | 63 | 48 | 40 | 38 | 22 | 13 | -9 | -13 | -15 | -14 | -7 | -10 | -12 | -12 | -11 | -5 | -8 | -10 | 10 |
| Management of companies and enterprises | 55 | 3 | 4 | 2 | 1 | -1 | -1 | -3 | -4 | -5 | -5 | -5 | -4 | -4 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -2 |
| Administrative and support services | 561 | 32 | 43 | 32 | 22 | 15 | 14 | 1 | -10 | -23 | -24 | -24 | -23 | -21 | -21 | -20 | -19 | -19 | -18 | -17 | -17 | -5 |
| Waste management | 562 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Educational services | 61 | 5 | 8 | 7 | 5 | 4 | 4 | 2 | -1 | -3 | -4 | -5 | -5 | -5 | -5 | -6 | -6 | -6 | -6 | -6 | -7 | -1 |
| Ambulatory health care services | 621 | 24 | 30 | 19 | 12 | 7 | 6 | -4 | -11 | -19 | -19 | -18 | -16 | -14 | -13 | -12 | -11 | -11 | -10 | -9 | -9 | -4 |
| Hospitals | 622 | 4 | 6 | 5 | 4 | 4 | 4 | 2 | 1 | -1 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -4 | -4 | -4 | -4 | 0 |
| Nursing and residential care facilities | 623 | 3 | 4 | 4 | 3 | 3 | 2 | 1 | 0 | -1 | -2 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -4 | -1 |
| Social assistance | 624 | 5 | 7 | 6 | 6 | 5 | 5 | 3 | 1 | -2 | -3 | -3 | -3 | -4 | -4 | -5 | -5 | -5 | -6 | -6 | -7 | -1 |
| Performing arts and spectator sports | 711 | 2 | 3 | 1 | 0 | -1 | -1 | -2 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 3 | 4 | 3 | 2 | 2 | 2 | 1 | 0 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -3 | -3 | -4 | -4 | -1 |
| Accommodation | 721 | 2 | 3 | 2 | 1 | 1 | 0 | -1 | -1 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -1 |
| Food services and drinking places | 722 | 15 | 21 | 18 | 14 | 12 | 11 | 6 | 0 | -6 | -8 | -9 | -10 | -10 | -11 | -12 | -12 | -12 | -12 | -13 | -13 | -2 |
| Repair and maintenance | 811 | 6 | 9 | 6 | 5 | 4 | 3 | 1 | -1 | -4 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -1 |
| Personal and laundry services | 812 | 9 | 11 | 7 | 4 | 2 | 2 | -2 | -5 | -8 | -7 | -7 | -6 | -5 | -5 | -4 | -4 | -4 | -3 | -3 | -3 | -1 |
| Membership associations and organizations | 813 | 4 | 5 | 4 | 4 | 3 | 3 | 1 | 0 | -2 | -3 | -3 | -3 | -3 | -3 | -3 | -4 | -4 | -4 | -4 | -5 | -1 |
| Private households | 814 | 8 | 10 | 7 | 4 | 2 | 2 | -1 | -3 | -6 | -6 | -5 | -5 | -4 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -1 |
| Other Industries | | 11 | 14 | 9 | 5 | 2 | 0 | -5 | -8 | -13 | -13 | -12 | -11 | -10 | -10 | -9 | -9 | -8 | -8 | -7 | -7 | -4 |
| State and Local | | 44 | 59 | 43 | 30 | 21 | 18 | 1 | -13 | -31 | -34 | -35 | -36 | -36 | -36 | -37 | -37 | -37 | -36 | -36 | -37 | -11 |
| **Total** | | **646** | **879** | **672** | **500** | **383** | **370** | **123** | **-76** | **-329** | **-345** | **-347** | **-337** | **-314** | **-308** | **-305** | **-294** | **-286** | **-270** | **-267** | **-271** | **-9** |

## Table A-3: Annual Job Impacts of WSPA

| Category | NAICS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and gas extraction | 211 | 0 | -1 | -2 | -4 | -6 | -8 | -11 | -13 | -15 | -16 | -16 | -16 | -16 | -16 | -16 | -16 | -15 | -15 | -14 | -13 | -11 |
| Utilities | 22 | 1 | 2 | 4 | 6 | 7 | 15 | 16 | 19 | 19 | 19 | 18 | 18 | 18 | 17 | 17 | 17 | 17 | 16 | 16 | 16 | 14 |
| Construction | 23 | 528 | 836 | 983 | 769 | 649 | 695 | 446 | 238 | -68 | -75 | -76 | -72 | -66 | -58 | -52 | -46 | -41 | -36 | -32 | -29 | 225 |
| Nonmetallic mineral product manufacturing | 327 | 4 | 5 | 4 | -2 | -5 | -7 | -11 | -14 | -17 | -18 | -18 | -18 | -18 | -19 | -19 | -18 | -18 | -18 | -18 | -18 | -12 |
| Fabricated metal product manufacturing | 332 | 12 | 18 | 20 | 14 | 10 | 10 | 5 | 1 | -5 | -5 | -4 | -4 | -4 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | 3 |
| Petroleum and coal product manufacturing | 324 | 0 | -1 | -2 | -4 | -6 | -8 | -10 | -12 | -13 | -14 | -15 | -15 | -15 | -15 | -15 | -15 | -14 | -14 | -14 | -13 | -11 |
| Chemical manufacturing | 325 | 2 | 3 | 3 | 2 | 0 | 0 | -1 | -2 | -3 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | -1 |
| Rest of manufacturing | 31-33 | 24 | 34 | 34 | 18 | 8 | 7 | -5 | -14 | -25 | -23 | -20 | -18 | -15 | -13 | -11 | -10 | -9 | -8 | -7 | -7 | -3 |
| Wholesale trade | 42 | 29 | 42 | 44 | 27 | 15 | 13 | -3 | -15 | -29 | -29 | -28 | -27 | -25 | -23 | -21 | -20 | -18 | -17 | -16 | -15 | -6 |
| Retail trade | 44-45 | 81 | 120 | 128 | 82 | 55 | 52 | 6 | -29 | -76 | -76 | -76 | -73 | -69 | -66 | -64 | -61 | -59 | -57 | -54 | -54 | -14 |
| Truck transportation | 484,492 | 12 | 19 | 21 | 14 | 10 | 9 | 2 | -4 | -12 | -12 | -12 | -12 | -11 | -11 | -10 | -10 | -9 | -9 | -9 | -9 | -2 |
| Monetary authorities | 521,522-525 | 18 | 26 | 27 | 16 | 10 | 10 | 0 | -7 | -16 | -15 | -14 | -12 | -11 | -9 | -8 | -7 | -6 | -6 | -5 | -5 | -1 |
| Securities and investments | 523 | 16 | 24 | 25 | 14 | 8 | 8 | -3 | -9 | -18 | -16 | -14 | -12 | -10 | -8 | -7 | -6 | -5 | -4 | -3 | -3 | -1 |
| Insurance carriers and related activities | 524 | 6 | 9 | 9 | 5 | 2 | 2 | -2 | -4 | -8 | -7 | -6 | -6 | -5 | -4 | -4 | -3 | -3 | -3 | -2 | -3 | -1 |
| Real estate | 531 | 26 | 39 | 41 | 26 | 18 | 17 | 1 | -10 | -27 | -27 | -27 | -26 | -25 | -23 | -23 | -22 | -21 | -20 | -20 | -21 | -6 |
| Professional and technical services | 54 | 73 | 123 | 145 | 112 | 91 | 91 | 53 | 21 | -23 | -32 | -35 | -32 | -27 | -22 | -26 | -25 | -21 | -17 | -13 | -18 | 21 |
| Management of companies and enterprises | 55 | 6 | 8 | 8 | 4 | 2 | 1 | -3 | -5 | -9 | -8 | -8 | -8 | -7 | -6 | -6 | -6 | -5 | -5 | -5 | -4 | -3 |
| Administrative and support services | 561 | 57 | 88 | 98 | 69 | 50 | 51 | 19 | -6 | -40 | -42 | -41 | -39 | -36 | -33 | -32 | -30 | -28 | -26 | -24 | -25 | 2 |
| Waste management | 562 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| Educational services | 61 | 10 | 17 | 20 | 16 | 14 | 15 | 9 | 4 | -4 | -5 | -6 | -7 | -7 | -7 | -7 | -7 | -7 | -8 | -8 | -8 | 1 |
| Ambulatory health care services | 621 | 44 | 64 | 68 | 43 | 28 | 30 | 5 | -12 | -37 | -34 | -32 | -28 | -24 | -20 | -19 | -17 | -14 | -13 | -11 | -11 | 1 |
| Hospitals | 622 | 7 | 12 | 15 | 12 | 11 | 11 | 8 | 5 | 0 | -1 | -2 | -2 | -3 | -3 | -3 | -3 | -4 | -4 | -4 | -5 | 2 |
| Nursing and residential care facilities | 623 | 5 | 9 | 11 | 9 | 8 | 8 | 5 | 3 | -1 | -1 | -2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -4 | -4 | 1 |
| Social assistance | 624 | 9 | 15 | 19 | 16 | 14 | 16 | 11 | 6 | 0 | -2 | -3 | -3 | -4 | -4 | -5 | -6 | -6 | -7 | -7 | -8 | 2 |
| Performing arts and spectator sports | 711 | 4 | 5 | 5 | 2 | 0 | -1 | -3 | -5 | -6 | -6 | -5 | -4 | -3 | -3 | -2 | -2 | -1 | -1 | -1 | -1 | -1 |
| Amusement, gambling, and recreation | 713 | 5 | 8 | 10 | 8 | 7 | 7 | 4 | 2 | -2 | -2 | -2 | -3 | -3 | -3 | -3 | -3 | -4 | -4 | -4 | -5 | 1 |
| Accommodation | 721 | 4 | 6 | 7 | 4 | 3 | 3 | 1 | -1 | -3 | -3 | -3 | -3 | -3 | -2 | -2 | -2 | -2 | -2 | -2 | -2 | 0 |
| Food services and drinking places | 722 | 27 | 43 | 52 | 42 | 36 | 38 | 24 | 13 | -5 | -8 | -11 | -12 | -13 | -14 | -15 | -16 | -16 | -16 | -16 | -17 | 6 |
| Repair and maintenance | 811 | 12 | 18 | 20 | 15 | 12 | 12 | 6 | 1 | -6 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -7 | -6 | -6 | -6 | 1 |
| Personal and laundry services | 812 | 17 | 25 | 25 | 15 | 10 | 10 | 0 | -6 | -15 | -14 | -12 | -11 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | -3 | 0 |
| Membership associations and organizations | 813 | 7 | 11 | 13 | 10 | 9 | 9 | 6 | 3 | -2 | -3 | -3 | -4 | -4 | -4 | -4 | -4 | -4 | -5 | -5 | -5 | 1 |
| Private households | 814 | 15 | 22 | 22 | 13 | 8 | 8 | 0 | -5 | -12 | -11 | -10 | -9 | -8 | -7 | -7 | -6 | -5 | -5 | -4 | -5 | 0 |
| Other Industries | | 20 | 29 | 31 | 18 | 10 | 9 | -3 | -13 | -24 | -23 | -22 | -20 | -19 | -17 | -15 | -14 | -13 | -12 | -11 | -11 | -5 |
| State and Local | | 78 | 119 | 132 | 96 | 73 | 75 | 35 | 2 | -42 | -48 | -52 | -53 | -53 | -52 | -52 | -52 | -51 | -51 | -50 | -51 | 0 |
| **Total** | | **1162** | **1798** | **2039** | **1490** | **1161** | **1211** | **610** | **133** | **-542** | **-565** | **-565** | **-539** | **-505** | **-463** | **-450** | **-429** | **-402** | **-382** | **-357** | **-364** | **202** |